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THE SNOWY RIVER VOLCANICS WEST OF BUCHAN, VICTORIA

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[Communicated by Dr J. A. Talent]

Abstract

The Snowy River Volcanics W. of Buchan fall naturally into two stratigraphic units. The lower unit, or Timbarra Formation, consists of conglomerate with interbedded finer grained sediments, tuffs, agglomerates and minor rhyodacites. It is faulted down on the W. against Ordovician sandstones and siltstones, and on the E. is faulted against a complex succession of rhyodacites, andesites, tuffs and minor intercalations of sediments considered, in aggregate, to be more or less equivalent to the Gelantipy Rhyodacite of the Deddick-Gelantipy district. Because of faulting the relationships between these two formations cannot be observed in the field, but there would seem to be at least 5,000 ft of Timbarra Formation and 10,000 ft of Gelantipy Rhyodacite. Separate member status has been accorded two other lithologic units, one in each formation. The Johnson Member of the Timbarra Formation is a succession of about 300 ft of siltstones with two interbedded ignimbrite flows occurring about the middle of that formation. The Fairy Member of the Gelantipy Rhyodacite is about 100 ft thick and consists of tuffaceous siltstones, in part calcareous. The Gelantipy Rhyodacite is overlain with slight disconformity by the Buchan Caves Limestone.

Introduction

The Snowy River Volcanics are a complex sequence of Lower Devonian acid lavas, tuffaceous sediments and tuffs outcropping in a longitudinal belt between the N.S.W. border and Nowa Nowa in E. Victoria. They were first studied by A. W. Howitt (1876) who discussed their complexity and relationships with the Devonian limestones of Buchan and Murrindal. Since Howitt's time, studies of the volcanics have been made in restricted areas to the S. of Buchan (Cochrane & Sampson 1950, Bell 1959), about Deddick and Wulgulmerang (Ringwood 1955), and at Bindi (Gaskin 1943). None of these studies has been concerned with the Buchan district where mapping of the limestones (Teichert & Talent 1958) has revealed normal contacts between the limestones and the volcanics, particularly along the Murrindal R. E. of Buchan and in the vicinity of the Caves Reserve to the W. of Buchan. These areas are clearly the most promising for study of the Snowy River Volcanics succession. The area chosen was bounded on the E. by the Caves Reserve, stretching westwards a distance of about 6 miles to the Timbarra R. It is a rugged area covered with heavy timber and scrub.

The project was facilitated by many people. Mr W. A. J. Saunders of the Geology Department, Royal Melbourne Institute of Technology, suggested the work, and gave helpful advice and criticism during the preparation of this paper. Dr J. A. Talent, of the Geological Survey of Victoria, suggested the area and gave freely of his time in discussions, and arranged for draughting of the map by the Mines Department of Victoria.

The following symbols are used:

MDV—Geological Museum of the Mines Department of Victoria, collected by Dr Talent.

RMIT—Geology Department of the Royal Melbourne Institute of Technology, collected by the author.

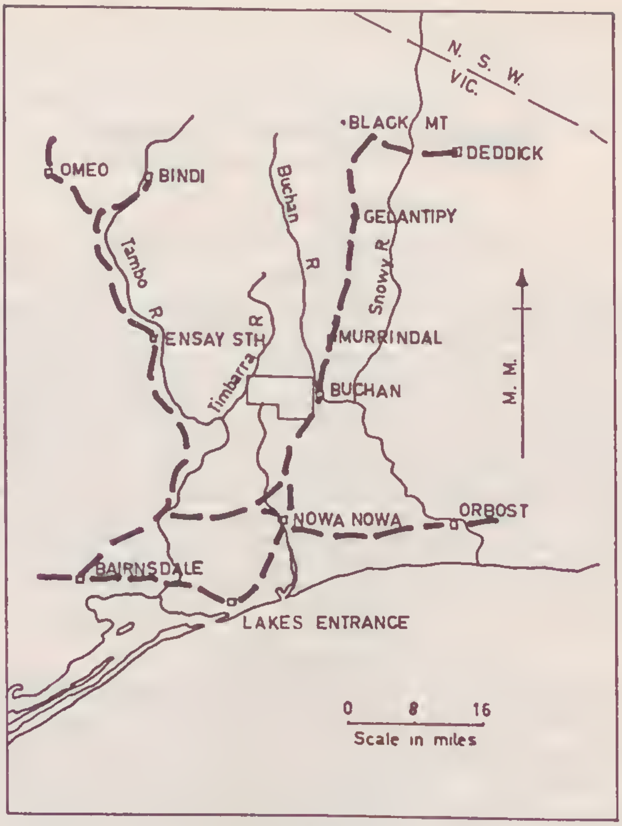


Fig. 1—Locality plan.

Stratigraphy

Ordovician

Extensive outcrops of strongly folded, frequently near vertical, micaceous sandstones, shales, siltstones and cherts, often intersected by quartz veinlets, occur in the W. of the area near the Timbarra R. There is invariably a faulted contact between these sediments and the Snowy River Volcanics in the mapped area. Although no fossils have been found in the area, the sediments are lithologically similar to graptolite bearing Upper Ordovican sediments occurring in a belt between Mt Tara and Nowa Nowa (Cochrane & Sampson 1950).

Lower Devonian

The Snowy River Volcanics outcropping W. of Buchan are broadly divisible into two units; an older unit, the Timbarra Formation, in which volcanic rocks are not prevalent, and a younger unit, the Gelantipy Rhyodacite in which volcanic and pyroclastic rocks predominate. The relation between the two divisions is as yet unknown.

In the area studied they are separated by the Yellow Water Holes Fault, which has an undetermined throw.

Timbarra Formation

This Formation is faulted at both base and top so its original thickness in this area cannot be assessed; it is possible a great portion of the formation is not exposed.

The base is faulted out against Ordovician sediments by the Timbarra Fault while the top is cut by the Yellow Water Holes Fault. Cross faults cause the width of outcrop to increase in the N.

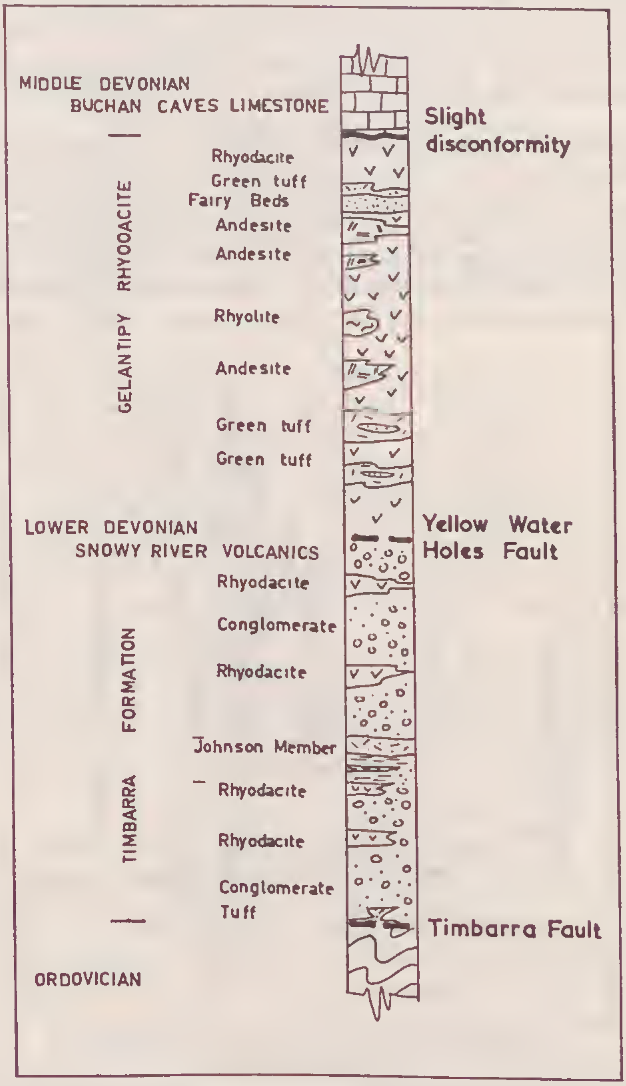


FIG. 2—Stratigraphic column for the Snowy River Volcanics W. of Buchan.

The Timbarra Formation is essentially conglomeratic, being pink-brown in colour and containing boulders to 3 ft in diameter. Finer grained sediments, tuffs and agglomerates, along with minor flows of rhyodacite occur interbedded with conglomerate in a cyclic arrangement. Along Mt Johnson Rd, for instance, the conglomerate consists of angular pebbles of sandstone and shale of apparent Ordovician lithology along with rare pebbles of red granite. The matrix of this weathered conglomerate is sandy and soft and the pebbles can be broken free by hand. In the

Timbarra R., near Wilkinson Cr., the conglomerate remains unleached and hard, forming rapids in the river.

Approximately two-thirds of the way from the Timbarra R. to Mt Johnson a flow of volcanic rock about 20 ft thick outcrops. It is composed largely of angular rock chips up to 5 mm in length set in a matrix of rhyodacite. The chips are mainly fined grained and igneous, although some purple coloured altered sediments also occur. This flow must have been particularly viscous, because of the high proportion of rock chips.

This rhyodacite is overlain by another 400-500 ft of conglomerate similar to that outcropping beneath the flow. This conglomerate is overlain in turn by a flow of rhyodacite about 30 ft thick. This particular rhyodacite is fairly coarse grained and moderately weathered, and seems to represent a break in conditions of sedimentation since the overlying sediments, here termed the Johnson Member, are fined grained and more or less well bedded, contrasting with the sediments beneath the rhyodacite.

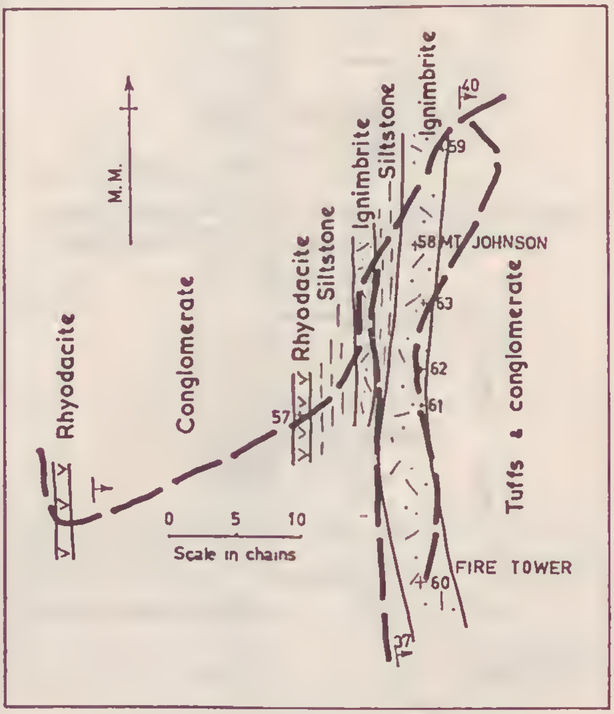


Fig. 3—Detailed geology about Mt Johnson.

Johnson Member:

The base of this member is composed of fine, cream to brown coloured sediments conformably overlying the above-mentioned rhyodacite and outcropping about 20 chains W. of Mt Johnson (Fig. 3). Siltstones of this member have yielded a solitary fossil plant identified by Mr J. Douglas as a conifer precursor.

Two flows of ignimbritic rock occur interbedded with the siltstones. The lowest flow is 10 ft thick and separated from the main flow by 20 ft of siltstone. The latter flow is 55 ft thick and, being tough, is responsible for the strike ridge that includes Mt Johnson.

The Mt Johnson ignimbrite is composed of the following: free quartz as medium grained subhedral phenocrysts, corroded and cracked in part; felspar as medium grained subhedral phenocrysts, highly altered, apparently orthoclase but with some plagioclase; glass as medium to fine grained fragments, constituting the ground mass of the rock (in thin section the glass fragments appear to be roughly segregated according to particle size); rock chips of very fine grained igneous rock up to 2mm in diameter. These rock particles, which occur in all thin sections, are angular, commonly brown coloured and contain crystals of sanidine. Quartz phenocrysts range 5-12%, orthoclase 5-8%, plagioclase 2-3% and rock chips 5-20% of the rock.

Welding of grains is rare and there is no evidence of any form of crystallization after deposition. It therefore resembles the radial phase of Marshall (1935). This, according to Marshall, is indicative of a low temperature of extrusion. The temperature, however, was high enough to permit bending of still slightly plastic crystals and to cause some crystals to weld, but too low to cause extensive welding or to allow post-depositional crystallization.

Ignimbrite, as originally defined by Marshall, is considered as being the product of the phenomena of incandescent tuff flow or nuée ardenté where the magma is highly charged with dissolved gases and 'boils over' to flood the surrounding country. A. Steiner (1960) has recently redefined ignimbrite and claims it to be the product of a lava which, because of its critical water content is highly fluid and has the inherent property of the groundmass unmixing to form two immiscible glasses. However that may be, the Mt Johnson rock conforms closely to descriptions of ignimbrite and is classified as an ignimbrite of rhyolite to dellenite composition. Owing to devitrification, one would not expect to test Steiner's theories by these Devonian ignimbrites.

After the second ignimbrite sheet was extruded, there was a reversion to deposition of conglomeratic sediments similar to those deposited prior to the Johnson Member. The top of this sheet is accordingly taken as the top of the Member. The overlying conglomerate is very similar to pre-Johnson Member rocks, although there are more finer grained tuffaceous sediments in this younger assemblage.

Gelantipy Rhyodacite

Rhyodacite of Gelantipy type (Ringwood 1955) outcrops S. from Gelantipy and occurs under the Buchan Caves Limestone at Buchan. Black Mountain and Deddick Rhyodacite types have not been noted in the Buchan area. It may be that the Timbarra Formation is a time rock equivalent of the Deddick and Black Mountain Rhyodacites or that Black Mountain and even Deddick Rhyodacites were extruded this far S., but no longer outcrop owing to movement along the Yellow Water Holes Fault.

The Gelantipy Rhyodacite is very complex in the Buchan district in that it consists of many minor flows which are of local nature and which are intersected by many small faults. Most of these flows are true rhyodacites though local flows of rhyolite and andesitic rock have been mapped, along with clastic and pyroclastic intercalations. It is proposed to discuss the rocks on a lithologic basis, grouping all rocks of similar type together, regardless of relative age. This system has been used on the map.

Rhyodacite:

This is the predominant volcanic rock type though there is wide variation in primary characteristics. Colour, due mainly to secondary alterations, varies from dark blue through grey to salmon pink, pink being most common in the area. The rhyodacite is in general medium to coarse grained and porphyritic, although fine grained tuffaceous rhyodacite occurs near the South Buchan turnoff from the Gillingall Rd, and also ½ mile W. of South Buchan. The groundmass is invariably fine grained and glassy.

MDV 7287, for instance, is a typical pink rhyodacite of Gelantipy type from just under the Buchan Caves Limestone. The phenocrysts are coarse grained and the groundmass is glassy. Approximately 15% of the section consists of subhedral to euhedral quartz, 30% felspar, predominantly plagioclase, and some highly altered ferro-magnesian mineral, possibly hypersthene. Magnetite is present as accessory: this mineral occurs in many sections but always in small amounts. Ilmenite occurs in small quantities in two sections—RMIT 2379 and 2380. Calcite is common throughout the suite, but more prevalent in the upper portions, possibly derived from leaching of the overlying limestone. MDV 7280 shows magnetite, apatite and serpentine associated as alteration products of an early formed ferro-magnesian mineral; this sort of thing is common in some of the younger flows.

When rock chips of rhyodacite are present they are usually slightly more basic than the flow and such a rock mix is here referred to as basic rhyodacite. RMIT 2473 from locality 14 is such a rock. In the hand specimen it is blue coloured, porphyritic, and tough; in thin section rhyodacite rock chips constitute an appreciable amount of the rock while the remainder is made up of quartz and plagioclase phenocrysts in a glassy groundmass. Flow structure is shown well in this section.

Another such occurrence of basic rhyodacite occurs just N. of the Cainozoic gravels 1½ miles S. of Buchan. At this locality the rock chips are of composition approximating andesite or dacite. The rock chips are fine grained and somewhat corroded in thin section RMIT 2395. The rhyodacite matrix is composed of medium grained quartz and felspar in a glassy groundmass. Flow structure is strong.

The rock chips are a local phenomena so that all the known basic rhyodacites grade laterally into normal rhyodacite.

There are two outcrops of a pink volcanic rock exhibiting a very strong flow structure emphasized by alternate hard and soft bands. In thin section RMIT 2439 and 2469 from localities 31 and 37 respectively, the rock is seen to contain up to 15% free quartz as fine to medium grained phenocrysts. The felspar is too fine grained and altered to afford reliable determination, but appears to be orthoclase. In lieu of a chemical analysis the rock has been classified as rhyolite on the basis of hand specimen appearance.

Andesite:

The only true andesite in this area outcrops near Yellow Water Holes Cr. just N. of the South Buchan enclave of Buchan Caves Limestone. The actual extent of this flow is not known as it is terminated by the N.-S. fault. It is hard medium grained dark coloured rock showing, in thin section (RMIT 2465), coarse grained phenocrysts of plagioclase up to 3 mm in length in a medium grained groundmass of andesine lathes.

All other rocks mapped as andesite are more accurately described as being of andesitic affinities in that quartz is occasionally present in appreciable quantities. The variation is such that gradation from andesite to quartz andesite and dacite occur over yards and hence they have been mapped as one rock type.

The 'andesite' underlying the Fairy Member is, in fact, a mixed igneous rock composed of particles of rhyodacite in an andesite to quartz andesite groundmass. The particles of rhyodacite vary in size up to one or more centimeters across but are commonly of the order of 2 or 3 mm. They vary in composition so that in part they are less acid than the groundmass. Thin section RMIT 2387 shows free quartz to be more common in the groundmass than in the inclusions. Some apatite and magnetite also occur in the inclusions. Thin section RMIT 2371 is of the same flow, ½ mile N. along strike. The rock chips are partially assimilated and have euhedral felspar crystals (? sanidine). RMIT 2476 is typical of most of this flow. In it chips of acid rock are clearly set in an andesitic groundmass.

Calcite is an important secondary mineral in all sections, making at least 20% in RMIT 2397. This secondary mineral may be due to leaching from the overlying carbonate rocks of the Fairy Member. This flow is responsible for the Spring Creek waterfall.

Immediately underlying the Fairy Member at locality 26 is a minor flow of fine grained, dark coloured, andesitic rock. In thin section RMIT 2393 there are phenocrysts of andesine in a groundmass including small crystals of plagioclase (? andesine), with a minor quantity of magnetite and apparent lack of ferro-magnesian mineral.

Some dark blue, medium grained, highly weathered rocks to the NE. of the area have also been tentatively mapped as andesite, for instance, a typical specimen RMIT 2497 appears devoid of quartz and too basic to be grouped with the other rhyodacites of the area.

Tuffs:

Pyroclastic rocks are common throughout the area. They are invariably lensing and vary in thickness and attitude over short distances. Apart from the mapped occurrences there are numerous tuff bands less than 2 or 3 ft wide throughout the area. These are interbedded with more massive lavas and sometimes afford a means of elucidating structure, but are difficult to trace for any appreciable distance.

The thicker deposits usually show evidence of water sorting, have rounded particles and sometimes have undoubted interbedded sediments. The tuffs are generally green in colour, fine to medium grained, and quite crumbly. There is up to 10% of well rounded quartz particles in specimens at most localities, though some of the tuffs are devoid of quartz particles visible to the naked eye. Material showing more than 10% of quartz particles generally shows evidence of the activity of water.

For instance, RMIT 2422, a tuff from Davidson Lane, has highly weathered felspar, but appears to lack free quartz; it has an approximate andesite composition. This tuff passes vertically into a fine grained, well bedded, slightly tuffaceous white quartzose sandstone (RMIT 2421) with angular quartz particles set in a fine grained tuffaceous groundmass. In this case the vertical change in composition is attributed to a change in the nature of tuff falling at this locality, but it is not always clear whether the presence or absence of quartz is due solely to the composition of the parent tuff and that there has been no water sorting.

A similar intercalation of sediment in tuff to the one just described occurs just S. of the Mt Johnson Rd, near Yellow Water Holes Cr. It is common to find minor flows of rhyodacite a few feet thick within the tuffs.

Fairy Member:

The most important sedimentary sequence in the Gelantipy Rhyodacite is that already named the Fairy Formation by Talent (1958). The rank accorded this stratigraphic unit depends on the rank given the associated sequence of volcanics, pyroclastics and sediments here regarded in aggregate as being in part at least equivalent to Ringwood's Gelantipy Rhyodacite. A case can be made for a fourfold subdivision of the complex lying between the Timbarra Formation and the Buchan Caves Limestone, and if there were better outcrops at least this amount of subdivision would be desirable. However, in view of the complexity of this area the poor exposures and the (perhaps consequent) lack of continuity of units below the Fairy beds, Ringwood's term Gelantipy Rhyodacite has been applied as a formational name embracing the whole complex; the term Fairy Member has been retained for the important and distinctive sedimentary succession occurring rather high in the sequence. There is no surety, however, that any of the beds above and including the main Spring Cr. Falls andesite are equivalent to any part of the Gelantipy Rhyodacite in its type area. Clarification of relationships will only be possible after detailed mapping between Buchan and Gelantipy.

The best development of the Fairy Member is in the section between Carson's Cr. and the strong tributary of Fairy Cr. lying immediately S. of and parallel to Spring Cr. There appears to be perhaps 75 ft of section in Spring Cr. in the vicinity of the fossil locality F3, but only 40 ft at Carson's Cr. In the upper part of Spring Cr. near the N. extremity of the mapped area there is another area of strikingly similar sediments exposed in a flat anticline. Though no fossils have been found there, their striking lithological similarity and stratigraphic position indicate they are almost certainly another belt of Fairy Member. They appear to be underlain along the axis of the anticline by andesitic rock and to be overlain (with an intervening belt of tuffs) by salmon rhyodacite identical with that separating the typical belt of Fairy Member from the Buchan Caves Limestone. There appears to be structural complication between this occurrence and the Buchan Caves Limestone about 2 miles to the E.

There is considerable variation of the strata of the Fairy Member from tuffaceous sandstones, breccias and siltstones to calcareous siltstones, clayey siltstones, to, on the S. side of Spring Cr. at fossil locality F3, impure limestone (Talent 1958, p. 45 for analysis). For instance, a breccia (RMIT 2394) contains 25% quartz, 15% weathered felspar and 15% rock chips in tuffaceous matrix. A typical sediment, such as MDV 7283, has poorly rounded grains of quartz and felspar in a matrix that includes tuffaceous material. Magnetite occurs in all sections available for study along with pyrite in one (MDV 7284). Some of the Fairy Member sediments, other than those in the vicinity of the limestone in Spring Cr. mentioned above, contain sufficient calcium carbonate to effervesce faintly with acid. Discrete bands of calcite occur in the sediments in the upper part of Spring Cr. here thought to belong to the Fairy Member.

Fossil locality F3 in Spring Cr. is a locality from which Dr Talent has collected a fauna including conchostracans, ostracods, gastropods, coprolites, fish teeth as well as some plant fragments.

Middle Devonian

Buchan Caves Limestone:

The contact between the Snowy River Volcanics and the Buchan Caves Limestone appears to be one of conformity. However, the beds underlying the Snowy River Volcanics vary from locality to locality, so the basal carbonate sediments do not rest on rocks that are strictly contemporaneous. It seems there may have been a short time break between the last lava flows of the Snowy River Volcanics and the basal dolomitic sediments of the Buchan Caves Limestone.

I have concerned myself with the Buchan Group away from the boundary with the volcanics only in the South Buchan enclave. Here outcrops are poor. However, poorly bedded stylolitic limestones at F2 just N. of the basalt boundary on the South Buchan Rd yielded the following fossils, identified by Dr Talent:

Spinella buchanensis
Breviphyllum recessum
Loxonema (?) sp.
Chonetes spooneri (?)
Favosites sp. (?) *bryani*
Bellerophon

Patches of limestone in the N. part of the enclave (Teichert & Talent 1958) were examined for fossils and yielded:

Spinella buchanensis
Small gastropods cf. *Anematina* or *Loxonema*
Algal pisoliths

Both faunas are characteristic of the middle part of the Buchan Caves Limestone.

The most important outcrops in this enclave are in the vicinity of Martin Cameron's Quarry where highly coralline limestones occur. These may well be upper Buchan Caves Limestone roughly equivalent to the horizon at Heath's Quarry. Otherwise, all known outcrops of Buchan Group sediments in the South Buchan enclave are definitely Buchan Caves Limestone. It seems best then to regard the enclave as belonging exclusively to this formation until Taravale sediments are proved, or other conclusive evidence is forthcoming.

Cainozoic

Basalt:

Basalt outcrops intermittently from South Buchan N. along the ridge followed by the Gillingall Rd, still showing clearly the course of an old stream valley into which basalt has spilled from extensive extrusions to the N. of Gillingall. Outcrops of basalt can be observed preserved in depressions, many feet lower in altitude than nearby Snowy River Volcanics, testifying to the youthfulness of the valley. For instance, just N. of the Mt Johnson turnoff from the Gillingall Rd, Tertiary basalt crops out in the road cutting 20 ft lower than Devonian rhyodacites less than 2 chains away.

A recent cutting on the South Buchan Rd just N. of the main basalt remnant has exposed another outcrop of weathered basalt. The altitude of this small outcrop is at least 60 ft less than the lowest point on the main South Buchan remnant; its relationships to the surrounding gravels are not clear. It may be a remnant of an earlier pre-gravel flow or a dyke.

The Gillingall-South Buchan basalt flow is petrologically somewhat variable, but it is essentially an olivine basalt, serpentinized in part. A typical specimen from Davidson Lane (RMIT 2472) has the following micrometric analysis:

Labradorite	47%
Augite	36%
Olivine	6%
Magnetite	3%
Secondaries	8%

CAINOZOIC SEDIMENTS:

The Snowy River Volcanics and the Buchan Caves Limestone are overlain in the S. by Cainozoic sediments which are poorly bedded, unconsolidated sands, silts and gravels. These have not been studied in the present investigation.

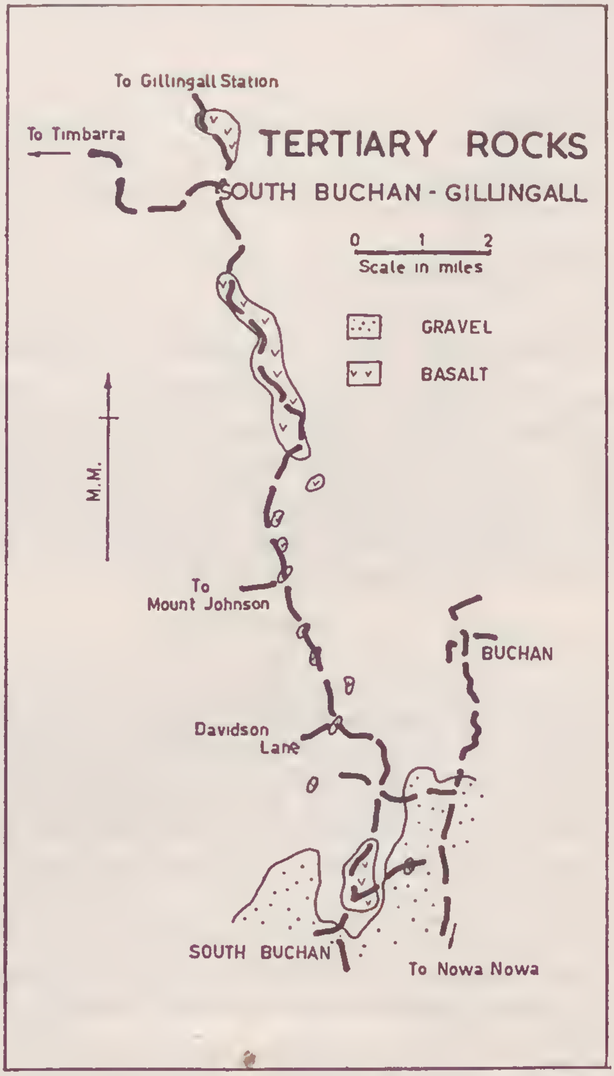
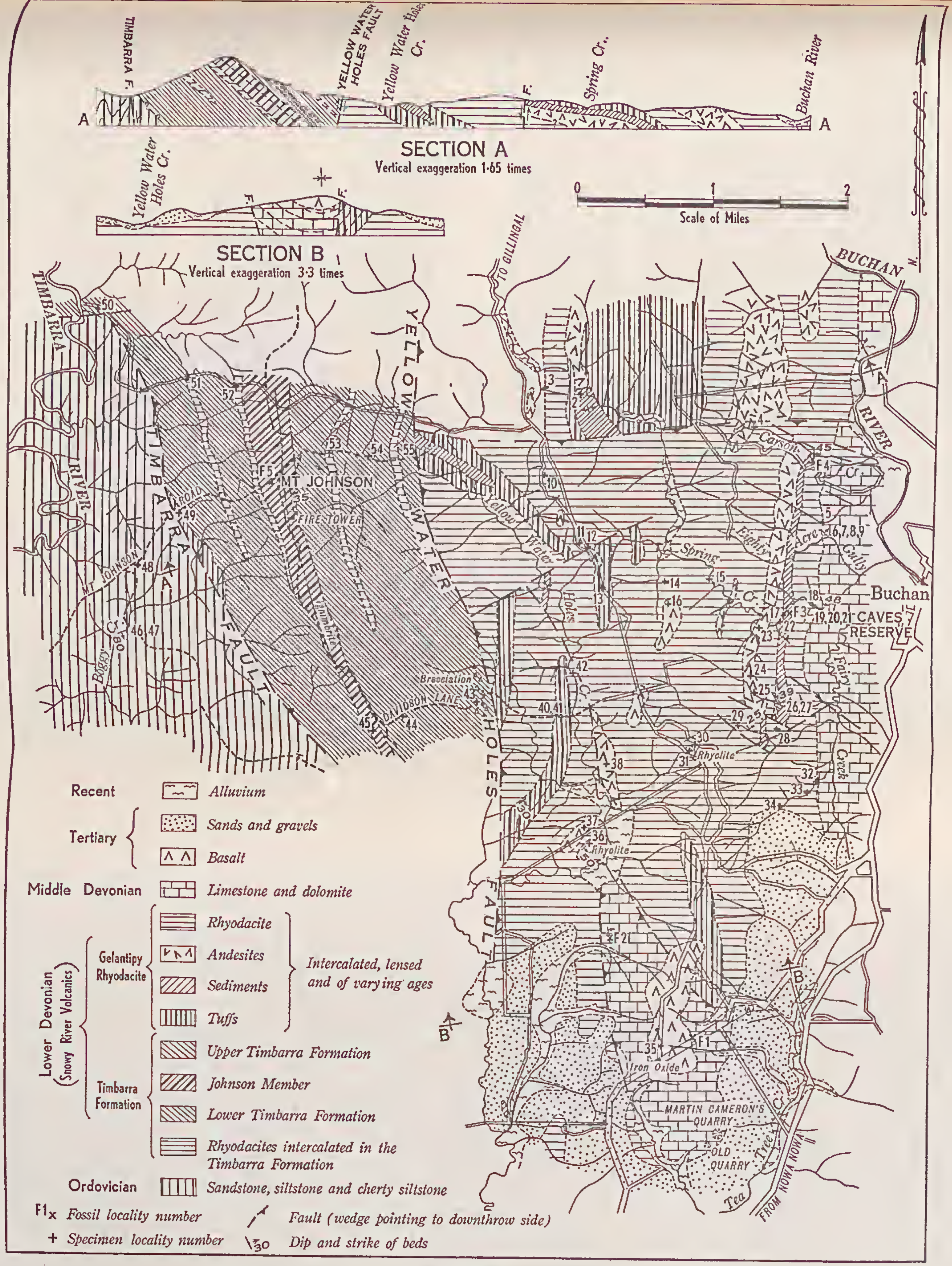


FIG. 4—The distribution of Tertiary rocks between South Buchan and Gillingall. Note the alignment of the basalt outliers indicating the course of the pre-basaltic valley. The heavy broken lines indicate roads.

Structure

Over most of the area the structure is simple with N.-S. strikes and easterly dips. In the N. of the area an anticline is well exposed in Spring Cr.; it is very flat with



SECTION A
Vertical exaggeration 1·65 times
TIMBARRA F.
YELLOW WATER HOLES FAULT
Yellow Water Holes Cr.
Spring Cr.
Buchan River
SECTION B
Vertical exaggeration 3·3 times
Yellow Water Holes Cr.
Scale of Miles
BUCHAN RIVER
TIMBARRA RIVER
TIMBARRA FAULT
YELLOW WATER HOLES FAULT
MT JOHNSON
FIRE TOWER
Ignimbrite
Brecciation
DAVIDSON LANE
MT JOHNSON ROAD
Boggy Cr.
TO GILLINGAL
Carson Cr.
Eighty Acre Gully
Spring Cr.
Yellow Water Holes Cr.
Buchan
CAVES RESERVE
Fairy Creek
Rhyolite
Iron Oxide
MARTIN CAMERON'S QUARRY
OLD QUARRY
Tea Tree Cr.
FROM NOWA NOWA
Recent
Alluvium
Tertiary
Sands and gravels
Basalt
Middle Devonian
Limestone and dolomite
Lower Devonian (Snowy River Volcanics)
Gelantipy Rhyodacite
Rhyodacite
Andesites
Sediments
Tuffs
Intercalated, lensed and of varying ages
Timbarra Formation
Upper Timbarra Formation
Johnson Member
Lower Timbarra Formation
Rhyodacites intercalated in the Timbarra Formation
Ordovician
Sandstone, siltstone and cherty siltstone
F1x Fossil locality number
+ Specimen locality number
Fault (wedge pointing to downthrow side)
Dip and strike of beds

Fig. 5—Map.